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ABSTRACT

A multidimensional model for measuring cultural differences (MCD) based on factor analytic theory and techniques is proposed. The model assumes that a cultural space may be defined by means of a relatively small number of orthogonal dimensions which are linear combinations of a much larger number of cultural variables. Once a suitable, cross-culturally equivalent factorial structure is established, cultural differentials are operationally defined as distances within the cultural space between loci having coordinates equal to factor scores or transforms thereof. The loci may represent individuals as well as group centroids. Additionally, MCD provides for quantitative operational definitions of commonly encountered constructs such as acculturation and biculturalism. Also included is an empirical demonstration of MCD's heuristic properties and advantages over traditional approaches to the measurement of cultural differences. Finally, the implications of the model for current issues in educational/psychological testing are discussed. (Author)

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A General Multidimensional Model for the Measurement of Cultural Differences

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A General Multidimensional Model for the Measurement of Cultural Differences

The relevance of cultural differences to psychological and educational measurement has been examined in the recent psychometric literature (Jensen, 1974a; Olmedo, in press; Petersen & Novick, 1976; Samuda, 1975). The primary focus has been on the study of issues of cultural bias as it pertains to "disadvantaged" minority populations such as Blacks and Hispanics who have backgrounds differing from those of the mainstream American society. Most discussions on this topic, however, have ignored the issue of variability within the populations under consideration by operationally defining culture as a qualitative variable in terms of ethnic group membership (Olmedo, J. L. Martinez, Jr. & S. R. Martinez, Note 1).

Undoubtedly, one of the reasons for this rather methodologically primitive approach has been the conspicuous absence of adequate quantitative indices of the extent to which individuals or groups from one racial/ethnic background differ from those of another, in terms of variables relevant to psychological and educational measurement. Although numerous studies have been conducted in the broad area of cultural differences, these efforts have been limited, in general, by the lack of a comprehensive conceptual framework that would provide the basis for systematic research. Typically, studies in this area have used unidimensional

approaches in which cultural differences are assessed by means of a single variable, or, at best, a very limited set of variables. This trend has resulted in the proliferation of empirical findings of the type, "Cultural groups A and B differ significantly on dependent variable X." The implications of differences on other variables, which may or may not be inter-related, is not usually investigated in a systematic fashion.

A few examples will suffice to illustrate the point. Differences involving Whites, Blacks, and/or Hispanics have been reported in intelligence (Loehlin, Lindzey & Spuhler, 1975), scholastic achievement (Jensen, 1974b), cognitive style (Ramirez & Casteneda, 1974), locus of control (Kagan, in press), cooperation/competition (Madsen & Shapira, 1970), affective meaning of family- and sex-role related concepts (J. L. Martinez, Jr., S. R. Martinez, Olmedo & Goldman, 1976), responses to various clinical and personality assessment instruments (Padilla & Ruiz, 1975) patterns of family interaction (Moynihan, 1965; Murillo, 1976), and numerous sociocultural variables (Mercer, 1976).

It is apparent that these groups have been found to differ on numerous aspects of a complex cultural spectrum. Many other differences are likely to be revealed by further research and thus become added sources of controversy. Little progress has been made, however, in elucidating the nature of the total spectrum. Many of these "cultural" variables are not likely to be independent of each other. Mercer (1976), for example, has shown that sociocultural variables such as socioeconomic status can account for up to 32% of the variance in I.Q. scores, while Jensen (1974b) has reported that ethnicity makes no significant contribution to the prediction of scholastic achievement independently of psychometric, personality, and background variables. Finally, it may be argued that many of these "differences" are artifacts resulting from imposed "etics" on the part of investigators when they study cultures other than their own (Brislin, Lonner & Thorndike, 1973).

It is contended here that a multidimensional approach is required for the proper study of cultural differences. This approach should provide for systematic investigation of the many variables involved with the goal of determining (1) their inter-dependence structure; (2) the number and nature of any orthogonal dimensions of cultural variability that may exist; and (3) the relative contributions of these dimensions to the explanation of cultural differences. Such an approach would go a long way toward the meaningful quantitative assessment of cultural differences, which in turn is an essential prerequisite for the proper study of the role of culture in psychological and educational measurement.

The Model[1]

The proposed "Multidimensional Model for the Measurement of Cultural Differences" (MCD) is conceptually similar to Osgood's Semantic Differential Technique for the measurement of meaning (Osgood, Suci & Tannenbaum, 1957), and is based on factor-analytic theory and techniques. It assumes that a "cultural space" may be defined by means of a relatively few orthogonal factors which are linear combinations of a much larger number of cultural variables (i.e., variables that reflect differences between the cultural groups under consideration). A second assumption is that the factorial structure (and hence the cultural space) is equivalent across groups. There is ample evidence that cross-culturally equivalent dimensions and structures may be found for many psychosocial characteristics (Brislin, et al., 1973; Osgood, May & Miron, 1975; Rodrigues & Comrey, 1974).

Once a suitable factorial structure is established, cultural differences

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[1] Due to space limitations the model is only briefly summarized in this section. However, a more formal and systematic presentation is provided in the enclosed Appendix.

(or "differentials") are simply defined operationally as distances in the cultural space between loci having coordinates equal to transforms of factor scores. Thus, by means of relatively simple computational procedures (see Appendix), cultural differences may be measured between individuals and/or groups. Furthermore, since the cultural space is cross-culturally equivalent, distances between loci have the same meaning whether the loci correspond to individuals or groups of the same or different cultural backgrounds. Thus, for example, it is possible to measure the extent to which an individual differs from his/her own cultural group, in addition to measuring the differential from any other group represented in the cultural space. Finally, MCD also provides for operational definitions of commonly encountered constructs such as "acculturation" and "biculturalism," since they are functionally related to reciprocals of cultural differentials.

A Demonstration of MCD

The following is an empirical demonstration of the model based on data from an earlier investigation of cultural differences between Anglo and Chicano high school students (Olmedo, et al., Note 1). It is not a test in the formal sense, because the nature and number of variables are limited and certain assumptions of the model have probably not been met. However, the demonstration will serve to illustrate the application of MCD and some of its heuristic properties.

The data consist of scores from 670 Anglo and 254 Chicano high school students on each of the 20 items from an acculturation inventory. The items include (1) questions tapping sociocultural characteristics such as language, nationality, and occupational status; and (2) ratings of the concepts "mother", "father", and "male" on the Potency Dimension of the Semantic Differential. In the original study, these items, selected from a larger pool, were regressed on a dichotomous criterion that reflected group membership (Chicano or Anglo). A

double cross-validation procedure yielded substantial and stable multiple correlations ($.66 \leq R \leq .80$) with the criterion.

For the purposes of demonstrating MCD, a factor analysis was performed on the 20 items. In the initial solution (principal factor components analysis with direct iterations) three substantially orthogonal factors emerged as providing a reasonable explanation of the data. In the initial solution, the three factors had eigenvalues of 2.99, 2.03, and 1.70 respectively, and taken together accounted for 33.6% of the total variance. Consequently, in the final solution three factors were extracted and rotated to an orthogonal solution (Varimax procedure).

Table 1 shows the three factors and the items with loadings $\geq |.35|$. The factors may be briefly described as follows:

Factor I: Nationality-Language (NL)

Individuals scoring high on this factor live in households headed by U.S. citizens, where only English is spoken. Individuals scoring low on this factor live in households headed by Mexican citizens, where the language mostly spoken is Spanish.

Factor II: Socioeconomic Status (SES)

Individuals scoring high on this factor live in households headed by white collar workers. Individuals scoring low on this factor live in households headed by blue collar workers.

Factor III: Father-Male Potency (FMP)

Individuals scoring high on this factor tend to rate the concept "father" as more complex and rugged, and the concept "male" as more complex, rough, and dangerous. Individuals scoring low on this factor tend to rate the concept "father" as more simple and delicate, and the concept "male" as more simple, smooth, and safe. In summary, individuals scoring high on FMP tend to ascribe more potency to the concepts "father" and "male" than do low-scoring individuals.

Insert Table 1 about here

Table 2 presents descriptive statistics for standardized factor scores. Unidimensional composite scores (SA) from Olmedo et al. (Note 1) are also included for comparative purposes. One advantage of the multidimensional approach is immediately apparent: It shows that the magnitudes of cultural and sex differences vary for the different factors, a finding totally obscured by the unidimensional approach. These results are illustrated in Figure 1, which shows the location of centroids corresponding to cultural, sex, and sex-by-culture groups. It is apparent that Chicano-Anglo differences are most substantial for Factor NL.

Insert Table 2 and Figure 1 about here

A Groups X Sex X Factors analysis of variance (least squares solution with Factors as the repeated measure; Kirk, 1968) revealed statistically significant effects attributable to Groups (F=366.7; df=1,920; $p < .001$), the Groups X Factors interaction (F=25.8; df=2,1840; $p < .001$), and the Sex X Factors interaction (F=10.7; df=2,1840; $p < .001$). A subsequent analysis of simple effects indicated that although Anglos scored significantly higher than Chicanos on all factors, 61% of the relative variance was attributable to Factor NL, 33% to Factor SES, and only 6% to Factor FMP. Sex differences, on the other hand, pertained primarily to Factor FMP, which accounted for 73% of the relative variance. An examination of Tables 1 and 2 reveals that males tend to ascribe more potency to the concepts "father" and "male" than do females, regardless of ethnic group membership.

Finally, it should be pointed out that a cultural differential (i.e., the distance between group centroids as computed in Figure 1) takes into account both variability due to Groups and variability due to the Groups X Factors

interaction[2]. This is particularly important in situations such as the one demonstrated here, where these interactions are substantial. In these cases, assessing cultural variability only in terms of differences between group means would result in considerable under-estimation of the magnitude of cultural differences.

Discussion

MCD has several important advantages over traditional approaches to the measurement of cultural differences. First, it provides a conceptual framework for programmatic research which is commensurate with the complexity of this area of investigation. Many variables may be studied simultaneously to generate the most parsimonious explanation of cultural characteristics, without obscuring important aspects such as the complex interactions among dimensions, cultural groups, and subgroups. Furthermore, since MCD is an empirically oriented approach with a minimum number of theoretical assumptions, it minimizes the risk of contamination due to stereotipic, ethnocentric interpretations (Brislin et al., 1973). Finally, although determining a factorial structure that will meet the assumptions of MCD is indeed a complex and arduous task, the measurement of cultural differences will be a simple process, once a suitable cultural space is defined.

The proposed approach also has direct implications for current issues of fairness in testing and selection procedures (Olmedo, in press; Petersen & Novick,

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[2]It may be shown, for example, that the cultural differential between Chicanos and Anglos shown in Figure 1 is equal to

$$\sqrt{2[(SS_G + SS_{GF})/\bar{n}]} = 11.47$$

where,

SS_G= sum of squares for Groups main effect
SS_{GF}= sum of squares for Groups X Factors interaction
$\bar{n}$= $[2/(1/n_1 + 1/n_2)]$; n_i = size of group i

1976). MCD provides a means of studying the validity of tests and the fairness of test-based selection procedures for individuals or groups as a function of the magnitude of their cultural differential(s) from the population(s) on which the tests were standardized. An important advantage of the proposed approach is that definitions of test and/or selection bias would need to depend no longer upon the race, ethnicity, or sex of the individual under consideration. Instead, these definitions would be based, as they should be, on the extent to which the individual is culturally different from the population for which the test and/or selection procedures were designed. This is particularly important in view of recent legal developments such as the Defunis and Bakke decisions, in which selection procedures based on ethnic group or sex quotas were ruled illegal.

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Table 1

Factor Loadings in Final Solution[a]

Item	Factor I: Nationality-Language (NL) - 50.8%[b]
Head of Household is U.S. Citizen	.90
Head of Household is Mexican Citizen	-.86
Mostly Spanish spoken at home	-.45
Only English spoken at home	.45

Item	Factor II: Socioeconomic Status (SES) - 29.0%[b]
Head of Household has white collar job	.67
Head of Household has blue collar job	-.57
Mother: simple-complex	.38

Item	Factor III: Father-Male Potency (FMP) - 20.2%[b]
Father: simple-complex	.51
Male: simple-complex	.47
Male: smooth-rough	.40
Father: delicate-rugged	.38
Male: safe-dangerous	.35

[a]Only items with loadings $\geq |.35|$ are included.

[b]Percent of total variance accounted by factor in final solution.

Table 2

Descriptive Statistics for T Transforms of Factor Scores by Sex and Cultural Group

		ANGLOS				CHICANOS				ANGLOS AND CHICANOS			
			Factor				Factor				Factor		
		SA[a]	NL	SES	FMP	SA[a]	NL	SES	FMP	SA[a]	NL	SES	FMP
MALES	M	54.6	52.0	52.2	51.8	38.2	42.4	44.9	49.1	50.0	49.3	50.2	51.0
	S.D.	5.8	4.3	7.5	6.9	9.8	16.3	7.7	7.3	10.2	10.3	8.2	7.1
	n		352				136				488		
FEMALES	M	54.5	52.9	51.3	49.7	37.9	44.8	45.6	46.6	50.0	50.7	49.8	48.9
	S.D.	5.0	2.0	8.0	7.9	9.1	13.8	8.2	8.9	9.7	8.2	8.5	8.3
	n		318				118				436		
MALES & FEMALES	M	54.5	52.4	51.8	50.8	38.1	43.5	45.2	47.9	50.0	50.0	50.0	50.0
	S.D.	5.4	3.4	7.8	7.5	9.4	15.2	7.9	8.1	10.0	9.4[b]	8.4[b]	7.8[b]
	n		670				254				924		

[a]Standard acculturation scores from Olmedo et al. (Note 1). SA's are T transforms of the linear combinations of item scores that provide the best least squares estimate of ethnic group membership.

[b]Standard deviations are less than 10 because factor scores produced by the regression estimate method may have standard deviations less than one (Rummel, 1970).

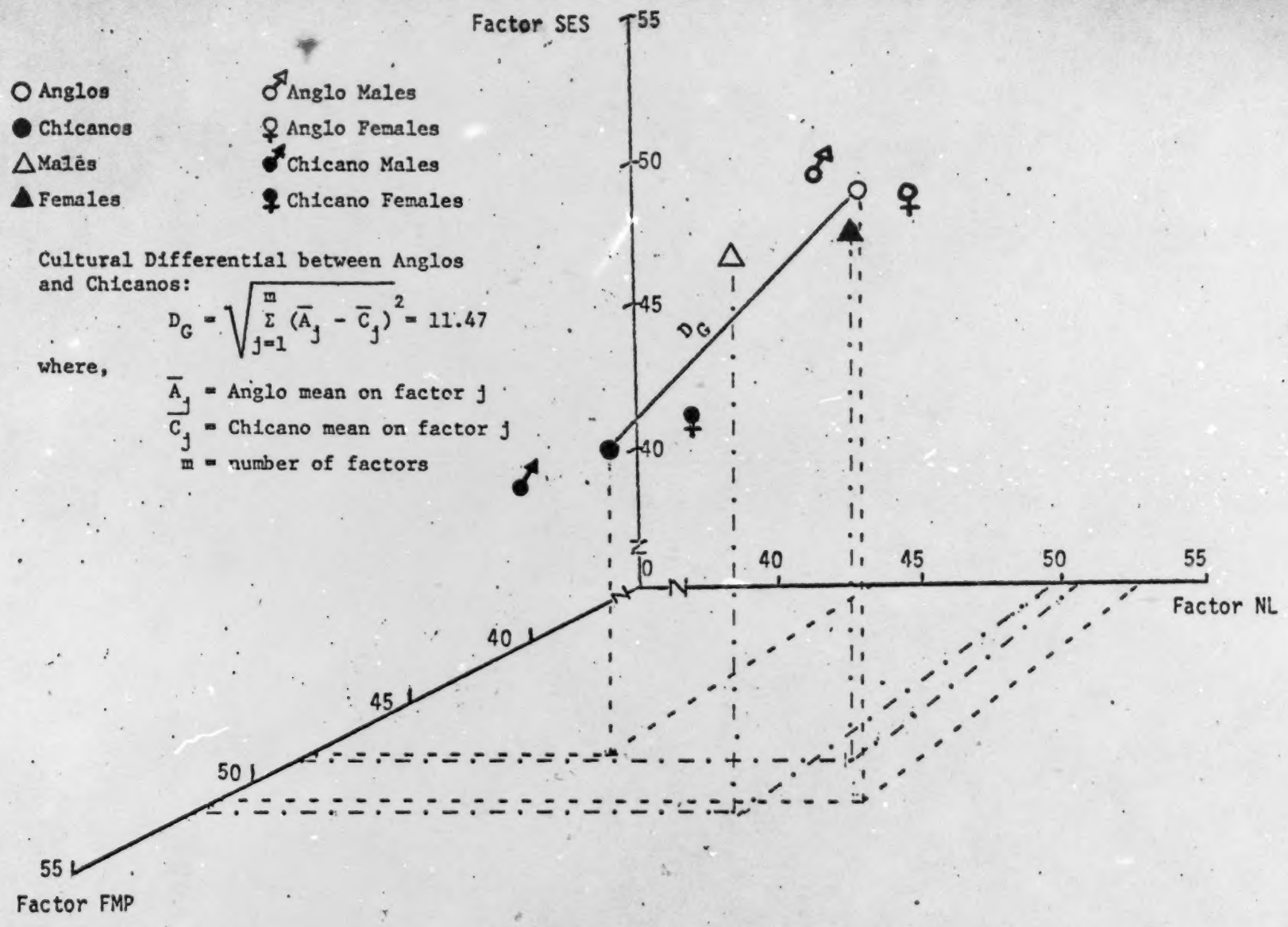

Figure 1. Cultural, sex, and sex-by-culture group centroids in 3-dimensional Cultural Space.

APPENDIX

A. Assumptions

A.1 If there are g identifiable cultural groups, then individuals from the k=1. . . g groups exhibit between- and within-group differences in a large but unknown number of "cultural variables."*

A.2 These variables represent vectors passing through the origin of a cultural Euclidian space of unknown dimensionality. A sample of h such variables, then, represents an h-dimensional cultural space.

A.3 Many of these variables, however, are not independent; therefore, m variables may be found such that:

A.3.1 $m < h$
A.3.2 The m variables are linear combinations of the h variables
A.3.3 The m variables are sufficient to differentiate among individuals between and within the g cultural groups
A.3.4 The m variables represent an m-dimensional cultural space which is equivalent for all cultural groups k=1. . . g and any combination $\binom{g}{k}$ thereof.

B. Definitions

B.1 Cultural Hyperspace H

Let the universal set W be a Euclidian space of unknown dimensionality defined by an unknown number of cultural variables, and let the set H be an h-dimensional space defined by a sample of h cultural variables. Then H is a cultural hyperspace and $H \subset W$.

B.2 Cultural Space S

Let the set S be an m-dimensional space defined by m linear combinations of the h cultural variables, where $m < h$. Then S is a cultural space and $S \subset H \subset W$. For the sake of simplicity, let S be defined by m orthogonal factors F_j extracted by means of standard factor-analytic techniques.

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* The model assumes the a priori definition of the term "cultural variable." Operationally, a cultural variable is any variable for which

$$\mu_k \neq \mu_{k'} \text{ for some } k \text{ and } k'$$
$$\text{and } \sigma_k^2 \neq 0 \text{ for all } k$$

B.3 Cultural Subspaces C_k

Let there be mg sets F_{jk} of real numbers f_{jk} such that

$$F_{jk} = \{f_{jk} | f_{jk} = \sum_{v=1}^{h} B_{vj} z_v\}$$

where,

f_{jk} = score on factor j for member of cultural group k
B_{vj} = factor-score coefficient for cultural variable v and factor j
z_v = standardized value on cultural variable v

And let there be g sets C_k such that

$$C_k = \prod_{j=1}^{m} F_{jk}$$
$$= \{(f_{1k},\ldots,f_{jk},\ldots,f_{mk}) | f_{1k} \varepsilon F_{1k},\ldots f_{jk} \varepsilon F_{jk},\ldots,f_{mk} \varepsilon F_{mk}\}$$

Then any set C_k is the cultural subspace corresponding to any cultural group k, and $C_k \subset S$ for all k.

B.4 Macrocultural Subspaces C'_r

Let there be g' sets C'_r such that

$$C'_1 = (C_1 \cup C_2)$$
$$\vdots$$
$$C'_r = (C_k \ldots \cup C_k, \ldots \cup C_g)$$
$$\vdots$$
$$C'_{g'} = (C_1 \ldots \cup C_k \ldots \cup C_g)$$

Then any set C'_r is the macrocultural space corresponding to any of the possible $g' = \sum_{k=2}^{g} \binom{g}{k}$ aggregates of the g cultural groups, and $C'_r \subset S$ for all r.

B.5 Cultural differential between any two individuals

The cultural differential D_I between any two individuals i and i' is the distance between their respective loci in the cultural space S.

$$D_I = \sqrt{\sum_{j=1}^{m}(f_{jik} - f_{ji'k'})^2} \quad , \quad \begin{matrix} i \neq i' \\ k \leq g \\ k' \leq g \end{matrix}$$

where,

f_{jik} = score on factor j of individual i from cultural group k and the i^{th} element f_{jk} of set F_{jk}.

B.6 Cultural differential between any two cultural groups

The cultural differential D_G between any two cultural groups k and k' is the distance in the cultural space S between the loci of their respective centroids $\bar{f}_k$ and $\bar{f}_{k'}$.*

$$D_G = \sqrt{\sum_{j=1}^{m}(\bar{f}_{jk} - \bar{f}_{jk'})^2} \quad , k \neq k'$$

where,

$$\bar{f}_{jk} = \sum_{i=1}^{n} f_{jik}/n \quad \text{and} \quad \bar{f}_{jk'} = \sum_{i=1}^{n'} f_{jik'}/n'$$

B.7 Cultural differential between any individual and any cultural group

The cultural differential between any individual i and any cultural group k is the distance in the cultural space S between that individual's locus and the locus of the group centroid.

$$D = \sqrt{\sum_{j=1}^{m}(f_{jik} - \bar{f}_{jk'})^2} \quad , \quad \begin{matrix} k \leq g \\ k' \leq g \end{matrix}$$

NOTE: The degree to which an individual shares the characteristics of a given cultural group is some function A=f(1/D). Particularly when $k \neq k'$, A would specify what is commonly referred to as "acculturation".

B.8 Cultural differential between any individual and any macroculture

The cultural differential D' between any individual i and any macroculture C'_r is the distance in the cultural space S between that individual's locus and the locus of the grand centroid $\bar{F}$ for all individuals such that $f_{jr} \epsilon F_{jr}$.

$$D' = \sqrt{\sum_{j=1}^{m}(f_{jik} - \bar{F}_j)^2}$$

where, $\bar{F}_j = (\sum_{k=1}^{k'} \bar{f}_{jk} n_k)/(\sum_{k=1}^{k'} n_k) \quad , \quad k < k' \leq g$

NOTE: When $n_1 = n_2 = \ldots = n_{k'}$, $\bar{F}$ will be located equidistant to all $\bar{f}_k$. In this case the degree to which an individual shares equally characteristics of the cultural groups in C'_r is some function M=f(1/D'). M specifies what is commonly referred to as "multiculturalism." If k'=2, M specifies what is commonly referred to as "biculturalism".

* Computation of the distance between unweighted centroids $\bar{f}_k$ and $\bar{f}_{k'}$ assumes that $n/n' \approx \eta/\eta'$ where η and η' are the sizes of populations k and k' respectively.